Life Sciences Division

Space Life Sciences

Ground Facilities Information Package

1999

A Companion Document
to
Agency Solicitations
in
Space Life Sciences

Issued by the International Space Life Sciences Working Group

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Introduction

This supplement is a companion to 1999 research solicitations released by agency members of the International Space Life Sciences Working Group: United States (National Aeronautics and Space Administration , NASA), the European Space Agency (ESA), and the space agencies of Canada (Canadian Space Agency, CSA), France (Centre National d'Ètudes Spatiales, CNES), Germany (Deutsches Zentrum für Luft-und Raumfahrt, DLR), and Japan (National Space Development Agency of Japan, NASDA). The various sections of this supplement provide a common basis for proposal preparation and submission by any eligible scientist, regardless of the country of origin.

Interested persons who do not have a copy of the appropriate agency research solicitation should contact one of the following persons for more information:

United States National Aeronautics and Space Administration (NASA)
Dr. Joan Vernikos, Director
UL/Life Sciences Division
NASA Headquarters
Washington, DC 20546-0001
U.S.A.
Phone: 202-358-2530
Fax: 202-358-4168

European Space Agency (ESA)
Dr. Didier Schmitt
Senior Life Scientist
Directorate of Manned Spaceflight and Microgravity
European Space Agency/ESTEC
MSM-GA
Keplerlaan 1
P.O. Box 299
2200 AG Noordwijk
The Netherlands
Phone: 31-71-565-4888
Fax: 31-71-565-3042

National Space Development Agency of Japan (NASDA)
Dr. Hiroyuki Matsumiya
Life Scientist
Space Utilization Research Center
Tsukuba Space Center, NASDA
Sengen 2-1-1, Tsukuba
Ibaraki, 305-8505
Japan
Phone: 81-298-52-2756

Fax: 81-298-50-2233

Canadian Space Agency (CSA)
Dr. Alan J. Mortimer
Program Scientist
Space Life Sciences, Space Science Program
P.O. Box 7275
Vanier Postal Station
Ottawa, Ontario K1L 8E3
Canada
Phone: 613-990-0801
Fax: 613-952-0970

Centre National d'Ètudes Spatiales (CNES)
Dr. Antonio Güell
CNES Direction des Programmes
18, avenue Edouard Belin
31401 Toulouse Cedex 4
France
Phone: 33-5-61-28-25-77
Fax: 33-5-61-27-40-13

Deutsches Zentrum für Luft-und Raumfahrt (DLR)
Dr. Günter Ruyters
DLR
Head, Life and Microgravity Sciences Program
Koenigswinterer Str. 522
Postfach 300364
53183 Bonn
Germany
Phone: 49-228-447-214
Fax: 49-228-447-739

Proposers submitting responses to agency solicitations should be aware that the proposal submission deadline for 1999 is **December 1, 1999**. Proposers should refer to their agency-specific solicitation for forms and instructions.

Special Ground Research Facilities

This document provides descriptions of special research facilities currently available for use by the international scientific community. These facilities are available to investigators for ground research at sites specified in the description. **Applicants must contact the person(s) identified at the end of each facility's description for additional scientific and technical information.** Applicants are cautioned that the cost of using these facilities, and the cost of travelling to and from the facilities, must be included in any proposal requiring them. Facility use costs **must** be negotiated and approved by the listed contact person **prior** to proposal submission.

Table 1. Cross-Reference Table

1.0 Research Facilities In The United States

1.1 The Vestibular Research Facility (VRF)

The Vestibular Research Facility (VRF) at the NASA Ames Research Center (ARC) provides unique, state-of-the-art equipment for ground-based studies of the effects of precise low-noise angular and linear accelerations on biological subjects. The VRF houses the following:

- Multi-Axis Centrifuge
- 30ft Human-Rated Sled
- Programmable Linear Sled

VRF hardware enables the study of responses to smooth, linear motion or to combinations of linear and angular motion over the frequency range of natural head movement. Specific space-related and non-space-related science questions may be addressed. The facility permits electrophysiological study of how complex linear or rotational accelerations are transduced during centrifugation, encoded by biological sensors, and processed by the brain. Interactions between linear and angular motion, as well as visual and proprioceptive inputs (peripheral, central, and motor) may be examined in any physiological system using electro-physiological, reflex, and behavioral methods. Sensorimotor interactions under complex linear and angular acceleration conditions may be studied systematically.

Information on the VRF is also available on-line at http://lifesci.arc.nasa.gov/cgbr/cgbr.html

1.1.1 The VRF Multi-Axis Centrifuge

The VRF Multi-Axis Centrifuge allows an investigator to apply up to 2g linear (centrifugal) acceleration to a gimbaled Specimen Test Container (STC) whose center is at a 1.0m radius from the centrifuge's axis of rotation. Gimbal motors allow an experimenter to apply DC to 5Hz angular motions (up to 500º/sec velocity and 500º/sec^2 acceleration) to the STC and its 54 pound payload during centrifugation. Fifteen electrically isolated slip-ring assemblies allow the recording of multiple channels of electrophysiological data continuously during centrifugation. This centrifuge accommodates small primates and rodents or smaller animal or plant specimens.

For further information, contact James Connolly at NASA/Ames Research Center. Telephone: 650-604-6483.

1.1.2 The VRF 30ft Linear Sled

The VRF 30ft Linear Sled uses air bearings to produce noise-free linear acceleration for studies of human perception of linear acceleration that do not confound vestibular cues with somatosensory ones. It also enables other physiological studies of humans and other species. The long track enables lower stimulus frequencies (periodic motion from 0.25Hz to 5.0Hz at 0.5g peak), and noise-free periods of constant linear velocity (trapezoidal profiles with acceleration and deceleration of 1.0g, and 100cm/sec constant velocities). It consists of an

experimental platform floating on air bearings on a granite surface. A gimbaled chair is mounted on the platform to accommodate human subjects or a specimen container for non-human subjects. Solid support is provided by a 30ft long block of granite. The 30ft linear sled can accommodate humans, small primates, rodents, or other biological specimens.

For further information, contact James Connolly at NASA/Ames Research Center. Telephone: 650-604-6483.

1.1.3 Programmable Linear Sled (PLS)

Programmable Linear Sled (PLS) uses air-bearings and linear motor technology to study vestibular system responses in small primates, rodents, or smaller animal specimens. This device allows studies of electrophysiological, reflex, or behavioral responses during precisely controlled linear oscillations (1.0Hz to 5.0Hz, $\pm$1g peak acceleration) parallel to or perpendicular to Earth gravity (i.e., horizontally or vertically). The PLS supports short-term studies of biological responses to linear acceleration.

For further information, contact James Connolly at NASA/Ames Research Center. Telephone: 650-604-6483.

1.2 Human-Rated Hypergravity Facilities

The NASA Ames Research Center has two hypergravity facilities that enable psychophysical and physiological research on humans and other species. They are:

- 20-g Human-Rated Centrifuge
- Human Powered Centrifuge.

Information on the Human-Rated Hypergravity Facilities is also available on-line at http://lifesci.arc.nasa.gov/cgbr/cgbr.html

1.2.1 The 20g Human-Rated Centrifuge

The 20g Human-Rated Centrifuge, NASA's only centrifuge currently human-rated (to 12.5g), enables delivery of accelerations with onset rates of 1g/sec to 12g and 0.5g/sec from 12g to 20g. It is frequently used to simulate Space Shuttle launch and landing profiles for a variety of payloads. The centrifuge has three enclosed cabs, each with a 16,000g-pound payload capacity. One cab, at a 29ft radius, contains a modified jet fighter seat in which a human volunteer sits during psychophysical or physiological tests. A second cab, located at the other end of the rotating arm, can be configured for rodents or other animals, plant species, or cell cultures. A third cab, located near the center of the centrifuge rotation can also be adapted to experimental requirements. This cab can be used as an on-center control for angular acceleration. Hypergravity exposures of minutes to hours are possible.

For further information, contact James Connolly at NASA/Ames Research Center. Telephone: 650-604-6483.

1.2.2 The Human Powered Centrifuge

The Human Powered Centrifuge is a 6.25ft radius centrifuge. A stationary bicycle beside the centrifuge or a recumbent bicycle onboard provides power for rotation of from minutes to hours, allowing human-generated gravitational forces for a payload of up to 500 pounds, without or with exercise, respectively . This centrifuge can also be driven by a motor. Human subjects have been found to be capable of generating up to 5g's of acceleration comfortably, reaching maximum rotation speeds of 50rpm. Electronic equipment for monitoring physiological parameters, such as cardiovascular function, temperature oxygen consumption, and other basic data, may be mounted onboard. Instrumentation-quality slip rings are available to transfer signals off-board for real-time monitoring.

For further information, contact James Connolly at NASA/Ames Research Center. Telephone: 650-604-6483.

1.3 Slow Rotation Test Facility

The slow rotation test facility was developed at Brandeis University to aid in the study of human behavioral and physiological responses to both predictable and aberrant force vectors generated by a rotating environment. The forces experienced under these conditions are very similar to those encountered in space vehicles that rotate to create artificial gravity.

The slow rotation test device is 22 feet in diameter and has a net weight in excess of seven tons. It is driven by a linear induction motor drive designed specifically for this application which has the capability of developing a constant torque of 2,350ft-lbs. The drive can produce a gravitoinertial force in excess of 4g within the room for a 6,000 pound payload. By means of preprogrammed velocity profiles, the motor drive system can accurately control the rate of speed of the device in either direction over the entire 0rpm to 35rpm speed range in increments as small as $1^{o}/sec^{2}$ to $10^{o}/sec^{2}$ increments; constant velocity can be maintained to within .001%. Over the entire speed range, z-axis vibration has been measured at <0.001g. The room can also sinusoidally oscillate over a wide range of frequencies.

The slow rotation room can accommodate a wide variety of test devices with onboard power for devices requiring either 110VAC, single phase or 220VAC, or three phase.

For further information, contact Dr. James Lackner at Brandeis University. Telephone: 617-736-2033.

1.4 Parabolic Flights: The KC-135 "Zero-G" Aircraft

This aircraft, a specially modified version of a Boeing 707, can generate 20sec to 30sec periods of microgravity and various levels and periods of hypergravity. This platform can be used to test

and validate experimental equipment and new devices to ensure that they will operate properly in varying gravitational fields. Furthermore, since multiple parabolas can be flown, it is also possible to conduct actual experimental studies.

For further information, contact Todd Schlegel, M.D. at the NASA Johnson Space Center. Telephone: 281-483-9643.

1.5 Non-Human Hypergravity Facilities

The NASA Ames Research Center has a suite of hypergravity facilities capable of supporting studies using non-human subjects and human and/or non-human tissues in addition to those listed above. These facilities include:

- Chronic Hyper-Gravity Exposure (24ft Diameter) Centrifuge
- International Space Station Test-Bed (8ft Diameter) Centrifuge
- Low Vibration Rotational Device

Information on the Non-Human Hypergravity Facilities is also available on-line at http://lifesci.arc.nasa.gov/cgbr/cgbr.html

1.5.1 The Chronic Hyper-Gravity Exposure (24ft Diameter) Centrifuge

The Chronic Hyper-Gravity Exposure (24ft Diameter) Centrifuge is designed to create hypergravity conditions up to 4.15g for small animal (such as rats, guinea pigs, rabbits, or primates) and plant research. The centrifuge has 10 radial arms and carries up to a total of 20 large, opaque, ventilated enclosures for holding animals and equipment. These enclosures can be located at different radii (variable from 4ft to 12ft at 6in intervals) to produce gravitational forces of up to four times Earth gravity on the floor of the enclosure. Three additional, smaller enclosures are available near the axis of rotation of the centrifuge, and eight stationary enclosures are available within the centrifuge rotunda to provide appropriate rotation and vivarium controls. Slip rings provide in-cage TV monitoring and instrumentation capability. Hypergravity exposures are chronic (from days to months) with two half-hour stops per week for feeding and change of bedding.

For further information, contact James Connolly at NASA/Ames Research Center. Telephone: 650-604-6483.

1.5.2 The International Space Station Test-Bed (8ft Diameter) Centrifuge

The International Space Station Test-Bed (8’ Diameter) Centrifuge is being configured to enable experiments in all habitats that will be used in the International Space Station. Experiments may be performed on plants or animals (e.g., rodents, small aquatics, insects, or cell cultures).

For further information, contact James Connolly at NASA/Ames Research Center. Telephone: 650-604-6483.

1.5.3 The Low Vibration Rotational Device (LVRD)

The Low Vibration Rotational Device (LVRD) is a single-arm centrifuge with a 10ft radius. It has a swing frame that can be positioned at various distances from the hub. Hypergravity levels up to 6g can be provided. Hydrostatic bearings provide for precise angular accelerations ($0.1°/sec^2$) with a rise time of 0.1sec and minimal vibration. Instrumentation-quality slip rings are available for off-board monitoring of experiment data.

The LVRD may be configured with an onboard CO_2 incubator to study the effect of short- or long-duration hypergravity exposure on cultured cells. This configuration is referred to as the Hypergravity Facility for Cell Culture (HyFaCC). Temperature, % CO_2, relative humidity, and g level data are transferred off-board through the slip ring assembly. The HyFaCC accommodates cell culture dishes of any type, but sealed vessels with vented caps are recommended for sterility. Additional equipment such as peristaltic pumps or automated cell culture devices may be accommodated. Studies up to 3-weeks duration may be run on the centrifuge. Long-duration studies will require stopping the centrifuge every 2 to 3 days for media replenishment unless a system to automatically replenish media is provided.

For further information, contact James Connolly at NASA/Ames Research Center. Telephone: 650-604-6483.

1.6 Bed Rest Research Facility (Human Research Facility)

The NASA Ames Research Center Bed Rest Research Facility is a $4100ft^2$ facility used to conduct studies of physiological responses of humans exposed to the bed-rest simulation that produces many of the physiological changes seen in space flight. Human subjects may be maintained comfortably for prolonged periods in either supine or 6° head-down bed-rest. During and following the bed-rest exposure, experimenters may conduct physiological studies of a variety of disciplines (e.g., endocrine, metabolic, and cardiovascular adaptations, musculoskeletal changes, exercise effectiveness, etc.).

Up to 12 subjects can live comfortably in this non-hospital environment for weeks or months, with all living requirements provided. The facility contains separate but readily accessible subject-living and test-administrative areas. It provides a controlled environment (temperature, light intensity, and photoperiod) and is suitable for research on ambulatory or bed-rested subjects. A horizontal shower is used for test subjects who must remain supine. Two bedrooms are sound-proofed and have adjoining bathrooms, making them ideal for either isolation or group interaction studies. A dumbwaiter is used to transport biological specimens (e.g., blood and urine samples) to a clinical laboratory on the floor above for processing. Biomedical data can be transmitted by hard wire from the subject's bed to a central data station for monitoring and recording. All meals are prepared in an integral modern kitchen, so that experiment dietary requirements may be strictly controlled. A dietician is responsible for planning and preparing all meals. Ambulatory subjects eat and relax in a central lounge/recreation/dining area.

Adjoining test areas contain a variety of physiological and exercise test equipment. In addition to medical monitoring equipment, the facility provides a lower-body negative pressure device, upright and supine bicycle ergometers, an upright treadmill, isokinetic exercise devices, and a tilt table to test orthostatic tolerance. Investigators can also bring additional experiment-specific equipment. For provocative testing of bed-rest de-conditioned subjects using hypergravity or vestibular testing, near-by human-rated facilities at ARC may be used.

For further information, contact James Connolly at NASA/Ames Research Center. Telephone: 650-604-6483.

1.7 Ground-Based Radiation Accelerator Facilities

NASA has signed Memoranda of Agreement (MOA) with two ground-based laboratories where energetic beams of protons and high-energy heavy ions are available; in particular, proton beams at the **Loma Linda University Medical Center** (protons with energies between 70MeV and 250MeV) and the Alternating Gradient Synchrotron (AGS) at **Brookhaven National Laboratory** (beams of iron and other heavy nuclei, with energies as low as 600MeV/nucleon, up to 10GeV/nucleon). Delivery of beam time at the Brookhaven facility has been directly funded by a contract between NASA and Brookhaven, and similar arrangements are intended for use of the beam time at Loma Linda University Medical Center.

1.7.1 Brookhaven National Laboratory

The AGS machine is a U.S. Department of Energy (DOE) facility that is funded by the DOE primarily for research in high energy particle and nuclear physics. Brookhaven is allowed by DOE to provide additional AGS beam time to other scientific users of the machine, as long as operating funds are provided by the sponsor of such proposed work. Use of the Brookhaven facilities requires a separate proposal, which is reviewed by a laboratory-appointed panel and is scheduled in accordance with available beam time and other laboratory resources. Once experiments are approved, they are required to satisfy the normal process of preparation for running at the AGS, which includes familiarization with AGS rules and policies (safety being the paramount consideration among these), and registration with the laboratory as a guest scientist.

User facilities have been developed at Brookhaven for radiation biology research, including cell cultures and small animals. These include the shielding cave containing the beam, the biological experiment station, and laboratory space and animal facilities in the Brookhaven Medical Department. A 10ft long optical bench for sample exposures is available in the cave, as well as beam handling, sample changing, and dosimetry instrumentation. The biological experiment station contains one area for cell culture equipped with a laminar flow hood and incubator, one short-term animal holding facility, and one area for physics/run-control use. In addition, laboratory space and access to animal facilities accredited by the Association for Assessment and Accreditation of Laboratory Animal Care, are available in the Medical Department subject to standard use charges. Brookhaven also has on-site housing accommodation for users (dormitory and apartment-style units).

Iron (^{56}Fe) beams at 600 MeV/nucleon and at 1 GeV/nucleon have been used for experiments to date; investigators who need to use other beams or energies should contact the Brookhaven liaison scientists listed below. Normally, circular beam spots are provided, with diameters up to 10 cm, and center-to-edge uniformity between 10% and 20%t (depending on dose rate -- high dose rate beams are less uniform than low-dose rate beams). Dose rates have been measured up to 11Gy/min. Investigators currently funded by the NASA program participate in research using these beams, and coordination of beam use with these investigators and institutions is actively encouraged. In particular, a physics and dosimetry group is available for investigators requiring their assistance.

For further information regarding Brookhaven National Laboratory, contact Dr. Marcelo Vazquez (e-mail: vazquez@image.bio.bnl.gov), Dr. Betsy Sutherland (e-mail: betsy@image.bio.bnl.gov), or Dr. Phil Pile (e-mail: pile@bnldag.ags.bnl.gov). The address is Brookhaven National Laboratory, PO Box 5000, Upton, NY 11973-5000.

1.7.2 Loma Linda University

Loma Linda University operates a facility for therapy of cancer and other diseases using accelerated protons from a synchrotron which is located within the medical center. Associated with the synchrotron are treatment rooms and all clinical services relevant to radiation therapy. Also associated with the synchrotron are an experimental area ("research room") which can receive a proton beam and an adjacent staging laboratory from which the accelerator can be operated and experiments may be configured prior to irradiation. Close to the accelerators is the new Chan Shun Pavilion, a wing of a research building whose first floor has been designated for a radiobiology research program with capabilities for modern cellular, molecular, and *in vivo* biology studies. Included in this structure is a laboratory dedicated for the use of visiting scientists whose research requires access to proton beams.

The basic beam line was designed to bring protons from 40MeV to 250MeV to the research room for experimental work while not interfering with patient treatments. The beam line will provide for flexible delivery of proton beams at doses, dose rates, energies, field sizes, and field uniformities that are adequate for many biology, physics, and materials science experiments. A Co-60 irradiator has been installed to provide gamma rays for control experiments.

For further information the Loma Linda University Medical Center, contact Dr. Gregory A. Nelson (e-mail: gnelson@lluci.llu.edu), Director, Radiobiology Program, Loma Linda University Cancer Institute, 11360 Mt. View Avenue, Hartford Bldg, Ste. B, Loma Linda, CA 92354. Telephone: 909-478-8366.

1.8 Space Human Factors Facilities

The Graphics Research and Analysis Facility (GRAF) and the Anthropometry and Biomechanics Facility (ABF) are managed by the Flight Crew Support Division at the Johnson Space Center.

1.8.1 Graphics Research and Analysis Facility

The Graphics Research and Analysis Facility has systems for computer modeling of humans and environments. It provides anthropometric, kinematic, and visibility analyses of humans working in 1g, 0g, or partial g. GRAF has access to strength and size databases and a physically-based system for computer modeling illumination for camera/eye vision with the ability to empirically collect luminance and illuminance data. It also has a large collection of models of the Shuttle, Spacelab, Spacehab, and ISS modules in which to perform this integrated analysis of humans working in space both EVA and IVA.

1.8.2 Anthropometry and Biomechanics Facility

The Anthropometry and Biomechanics Facility collects and analyzes strength, force, and motion data, in the Weightless Environment Test Facility (WETF) and in the KC-135 0g aircraft. Equipment includes Lido dynamometers, Ariel Motion Analysis Systems, and waterproofed and KC-135-qualified force plates. The ABF personnel are experienced in collecting data from suited subjects, as well as on the Precision Air Bearing Floor.

For further information, please contact Dr. Francis Mount at the Johnson Space Center. Telephone: 281-483-3723.

2.0 Research Facilities In Europe

2.1 Parabolic flights – Airbus 300

The European Space Agency (ESA) and CNES both offer parabolic flight opportunities utilising an Airbus 300. In principle, campaigns can be applied for both organizers.

This aircraft, a specially modified version of an Airbus 300, can generate 20sec to 30sec periods of microgravity and various levels and periods of hypergravity. This platform can be used to test and validate experimental equipment and new devices to ensure that they will operate properly in varying gravitational fields. Furthermore, since multiple parabolas can be flown, it is also possible to conduct actual experimental studies.

For ESA campaigns, please contact Mr. B. Elmann-Larsen, ESA/ESTEC Telephone 31-71-565-3322 or consult ESA's homepage for Manned Space Flight on www.estec.esa.nl/spaceflight/.

For CNES campaigns please contact Monsieur Denis Thierion (e-mail: denis.thierion@cst.cnes.fr), CNES, 18 avenue Edouard Belin, 31055 Toulouse Cedex, France. Telephone: 33-61-27-32-48. Fax: 33-61-28-21-65.

2.2 Research Facilities In Germany

2.2.1 Microgravity User Support Center

The DLR Microgravity User Support Center (MUSC) is the German user support center for research under space conditions. The MUSC is equipped with laboratory infrastructure, simulation facilities, experiment control rooms, user rooms for science monitoring and data evaluation, a user information area with a microgravity library, and the information system ARIADNE. Additional equipment and laboratories are located in the Institute of Aerospace Medicine. The Institute of Aerospace Medicine offers a unique infrastructure for applications in an international scope of space biology and human physiology research, providing support for ground-based research, payloads, and Space Station utilization for interagency investigations in cell and molecular biology, systems biology, plant biology, botany, and zoology.

For 0g simulations, hypergravity experiments, and extended ground-based research, the following infrastructure and facilities can be utilized for integrated investigations in the above mentioned fields of research:

- Fast rotating clinostats with online microscopic observation
- Cuvette clinostats
- STATEX incubator for small petri dishes with reference centrifuge
- BIOLABOR double rack
- Slow Rotating Centrifuge Microscope (NiZeMi lab model, up to 5g)
- Cultivation chambers for Biorack containers Type I and NiZeMi
- Several centrifuges including large centrifuge
- Large-scale Magnetic Resonance device for biological and biomedical investigations (imaging, microscopy, and spectroscopy)
- Tilting microscope
- Data and image processing capabilities
- Computer-based fluorescence microscopy (Zeiss Attofluar)

For further information regarding the Microgravity User Support Center, contact Dr. Marianne Schuber (e-mail: Marianne.Schuber@dlr.de), German Aerospace Center (DLR), Institute for Aerospace Medicine, Linder Höhe 45, D-51147 Köln, Germany. Telephone: (49)-2203-601-3523.

2.3 Research Facilities In France

2.3.1 Clinical Research Facility

The Clinical Research Facility (CRF) is a 1000m^2 (10,700ft^2) multi-purpose facility located within the Toulouse Rangueil Hospital. It is operated by MEDES (Institut de Médecine et Physiologie Spatiales), a subsidiary of the French Space Agency, Toulouse Hospital, the French Atomic Energy Commission, and several universities and research centers.

The CRF has been designed to host most of the ground-based clinical or human factors experimental research necessary to conduct space research such as:

- simulation of effects of the space environment (bed rest, confinement, circadian rhythms, etc.)
- performance of experiment verification tests or control experiments
- testing of equipment or procedures
- medical screening and check-up for healthy volunteers
- training courses of students and hosting of Ph.D. students

CRF has access to the biomedical facilities of a high standard hospital (NMR, CT scan, biological analyses). Its internal equipment includes the main required devices to test and monitor specific physiological functions (LBNP, tilt table, rotating chair) and to handle biological samples.

It allows monitoring of the main environmental parameters or parameters linked to the subject, such as diet, activity (24 hour video monitoring), temperature (2°C to 25°C ± 0.5°C), acoustics (isolation of 60dB from external environment, background less than 35dB), and lighting (natural/artificial ranging from 0 to 500 Lux).

CRF capacity ranges from:

- 4 beds for strictly controlled sleep or alertness studies, enabling blood sampling and physiological recordings without disturbing the patient
- 6 beds for strictly controlled sleep or alertness studies
- up to 26 beds for miscellaneous tests

CRF is served by highly skilled professionals matching the requirements of good clinical and good laboratory practices. Services will be strictly tailored to the needs of the investigators. They can be limited to a simple logistics accommodation, hosting of researchers, and the coordination of international multicentric studies.

For further information, contact Dr. Anne Pavy le Traon (e-mail: Anne.Pavy-Le.Traon@cst.cnes.fr), Clinique de l'Espace, 1 avenue Jean Poulhes, 31054 Toulouse Cedex, France. Telephone: 33-62-17-49-50. Fax: 33-62-17-49-51.

2.3.2 Center of Assistance for the Development of Microgravity Operations in Space (CADMOS)

The CADMOS, located at the Toulouse Space Center, was created in 1991 to provide technical and operational support to scientific users in the field of microgravity sciences. It includes various laboratories and a control center which are described below.

Technical Support: The CADMOS provides means to prepare experiments in the field of physiology and biology. The CADMOS is equipped with laboratory areas including ground model facilities and test benches. The following instruments are currently available:

- **Physiology**
  - PHYSIOLAB (cardiovascular physiology)
  - COGNILAB (sensorimotor physiology)

- **Biology**
  - FERTILE (amphibian development)
  - IBIS (cellular biology, development)

These instruments can be used for ground-based studies and for pre- and post-flight investigations. A user information area is also implemented with microgravity experiments and facilities documentation, vehicle information documentation, an archive, and a user database.

Operational Support: The CADMOS control center provides means for remote control of space experiments. This control center has already been used during several missions, including Shuttle flights and Mir missions. Information from space is made available to the scientists on the ground via audio and video links, as well as telemetry. Telescience capabilities can also be provided.

The CADMOS is equipped with a specific control room, a private video-conference room, user rooms for data monitoring and evaluation, technical premises, and reception and meeting rooms. These technical and operational supports are located in the same building.

For further information, please contact Mrs. G. Gargir, DSO/ED/USS/D, Bpi 2221, 18 avenue Edouard Belin, F-31401 Toulouse Cedex 4, France. Telephone: 33 5 61 45 56. Fax: 33 5 61 28 29 59.

2.4 Research Facilities In The Netherlands

2.4.1 The Dutch Experiment Support Center

The Dutch Experiment Support Center (DESC) is a non-profit initiative tasked to provide support for acceleration research. The DESC initiative is supported by the Space Research Organization of the Netherlands (SRON) and the Netherlands Agency for Aerospace Programs (NIVR). DESC supports, initiates, and facilitates acceleration research by providing know-how and access to ground-based research facilities and by offering services and laboratory assistance for ground-based and flight experiments. It supports the science community in ground research by providing access to the MidiCAR centrifuge, the rodent centrifuge, the Random Positioning Machine (RPM), the Free Fall Machine (FFM), the levitation magnet, small clinostat, the MaxiCAR launch simulator, and a parabolic aircraft. DESC supports also the development and test of hardware for biological or related experiments like Laboratory Support Equipment (microscopes, sensors, various microscopes) and experiment modules (e.g. plunger units), test and implementation of hardware on the RPM, FFM or centrifuges.

The main DESC laboratory and facilities are located at the Free University in Amsterdam, The Netherlands, providing the following gravitational research facilities:

- MidiCAR cell and tissue culture centrifuge (up to 100g)
- Random Positioning Machine (RPM) (simulated micro-g or partial g (0.1g to 0.9g))
- Small bench-top clinostat.

DESC provides access to associated facilities for acceleration research not located at the Free University such as:

- Free Fall Machine (FFM) (900msec free fall followed by about 20msec to 80msec of 20g)
- Large diameter (animal) centrifuge (1g to ~ 8g)
- Levitation magnet
- Parabolic aircraft

DESC has direct access to the following facilities at the Free University:

- General research lab
- Dedicated cell and tissue culture lab and infrastructure (incubators, flow-benches, etc.)
- Various microscope systems: brightfield, darkfield, phase contrast, fluorescence, inverted, polarization, video, stereo / photo, image analysis, etc.
- Light microscopic and electron microscopic preparation facilities: embedding, standard LM and EM microtomes, rotating saw-blade microtome, staining techniques, etc.
- Atomic Absorption analysis
- Specific ion measurements
- Various gel electrophoresis set-ups
- Fluid shear stress experiment set-up
- Standard molecular biology techniques

Through embedding in associated research labs at the university, DESC has access to other facilities. For example:

- Radio-nuclear research facilities (Class-B status)
- Dedicated molecular biology lab
- Dedicated biochemistry lab
- Dedicated microbiology lab
- Specialized light microscope and image analysis facilities: CLSM, IBAS, etc.
- Electron microscopes: TEM, SEM, AEM, element analysis
- Animal research facilities
- Central sterilization facilities

For further information about the Dutch Experiment Support Center (DESC), please contact Dr.ing. Jack J.W.A. van Loon (e-mail: DESC@wxs.nl or J.van_Loon.ocb.acta@med.vu.nl), ACTA-VU, Dept. Oral Biology, van der Boechorststraat 7, 1081 BT Amsterdam, The Netherlands; telephone: 31-20-444-8686 / 8664, fax: 31-20-444-8683

DESC web page: http://www.desc.med.vu.nl

3.0 Research Facilities In Japan

3.1 Ground-Based Accelerator Facility (HIMAC)

The Heavy Ion Medical Accelerator at Chiba (HIMAC) is a synchrotron facility in the National Institute for Radiological Sciences (NIRS), Chiba, Japan, dedicated for medical therapy and related research. The NIRS also provides research opportunities for domestic and international researchers to conduct radiological, biological, and physical investigations through an HIMAC annual solicitation. The facility is used for medical therapy during the day and is open for researchers at night. The HIMAC has two types of research ports: the Biology Port and the Physics Port.

The synchrotron generates accelerated particles of various nuclei with a cyclic period of 3.3sec. The flux ranges from 100 to 10^7 particles/spill. The diameter of the beam spot ranges from 10mm to 20mm in the Physics Port, and 200mm in the Biology Port. In the Physics Port, dose and LET should be evaluated separately because the counts are only essential in physical experiments. In the Biology Port, the dose and LET are evaluated by instruments installed at the port (ion chamber along with calculation for dose, and LET). The calculated dose and LET are provided to users in each irradiation by operators.

Carbon ions of 290MeV/nucleon at 1.8×10^9 particles/spill are currently available during weekdays for medical therapy. Carbon ions are available for researchers conducting physics or biology experiments during weeknights. If the experiments require ions other than carbon ions, the experiments must conducted during the weekend (Friday night to Sunday morning).

The following are the currently available beams:

Physics Ports:

Particle	Energy Range (MeV/nucleon)	Particle fluence (particles/spill)	
		Port I	Port II
He	6 - 230	2.0×10^{11}	1.2×10^{10}
C	6 - 430	↓	↓
N, O	6 - 400	↓	↓
Ne	6 - 600	↓	↓
Si	6 - 800	↓	
Ar	6 - 390		2.4×10^8

Biology Port:

Particle	Energy Range (MeV/nucleon)	Particle fluence (particles/spill):

He	6 - 230	1.2×10^{10}
C	6 - 430	
N, O	6 - 400	
Ne	6 - 600	
Si	6 - 600	
Ar	6 - 500	2.7×10^{8}

Other available ions, but under testing:
P (160, 230), Fe (500), Xe (290, 500), Kr (500)

Particle fluence (pps):

Physics Port I	2.0×10^{11} (He) – 1.0×10^{11} (Ar)
Physics Port II	1.2×10^{10} (He) – 2.4×10^{8} (Ar)
Biology Port	1.2×10^{10} (He) – $2.7\ 10^{8}$ (Ar)

Detailed information on HIMAC and its utilization can be obtained from the following points of contact. Applications must be submitted well in advance.

Kazunobu Fujitaka (e-mail: fujitaka@nirs.go.jp), National Institute of Radiological Sciences, 4-9-1 Anagawa, Inage, Chiba 263-8555, Japan. Telephone: 81-43-206-3230. Fax: 81-43-251-4836.

Ms.Yuka Machida (e-mail: yuka_m@nirs.go.jp), National Institute of Radiological Sciences, 4-9-1 Anagawa, Inage, Chiba 263-8555, Japan. Telephone: Tel: 81-43-206-3230. Fax: 81-43-251-4836.